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A Mechanized System for Handling Live Poultry

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Without the support of Marell Poultry Inc., Murrayville, Ga. (through Tom Folger) and many coop manufacturers, this system could not have been developed. The equipment for the system was developed at Marell, which also contributed financial support, plant facilities, and personnel. Poultry coop manufacturers developed coops for field testing that would be compatible with the system, and bore the cost of coop development.

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ILLUSTRATIONS

A Mechanized System for Handling Live Poultry

By A. D. Shackelford, J. H. Holladay, and J. E. Thomson[1]

ABSTRACT

Methods and equipment were developed to mechanize and automate the receiving-dock handling of live poultry and transport coops. Developments include a new large-door coop to make bird removal easier, a modification of the lift truck mast to handle increased loads safely, an automated conveyor system for moving stacks of coops, mechanized bird removal, transport of live poultry to the hanging stations on a belt conveyor, and mechanical assistance for stacking empty coops. Benefits include labor reduction of approximately 30 percent in the hanging operation and a reduction in the total physical work required in normal receiving-dock handling of the poultry and coops. The system is now commercially available and (with some minor variations) has been installed in several poultry processing plants. Index terms: automation, mechanization, poultry, poultry processing.

INTRODUCTION

Improvements in handling coops of live poultry (and emptied coops) at the processing plant have not kept pace with improvements in other parts of the plant or other parts of the industry. Almost all of the 3.6 billion broiler chickens processed in the United States in 1977 were transported to the processing plants in standard poultry coops and handling poultry in standard coops is a labor-intensive operation.

A few mechanized assisting devices are now used, but the amount of manual labor required for this difficult and unpleasant work has remained high. At the processing plant's receiving dock, workers often unload coops from the transport truck or trailer entirely by hand. In the partly mechanized methods, stacks of coops are transferred from the transport truck to the receiving dock by clamp truck or (if the stacks are on pallets) by forklift truck, then workers unstack the coops by hand. Each 75-pound coop is then manually placed on a conveyor for movement to the hanging station, where workers open the coop door, remove the broilers, and place them in shackles for conveyance into the plant for processing.

Other mechanized improvements include an automated coop-unstacking machine (Shackelford et al. 1975), the Poultrans system (Broiler Industry 1975), and the University of Georgia automated rearing facility (Reed 1974). In the Poultrans system, broilers are transported to the processing plant in an enclosed trailer equipped with a self-contained air-conditioning system for ventilation and belt conveyors to load and unload the birds. In the University of Georgia system, the ready-to-market broilers are mechanically

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FIGURE 1.—Prototype of side-door coop unloader.

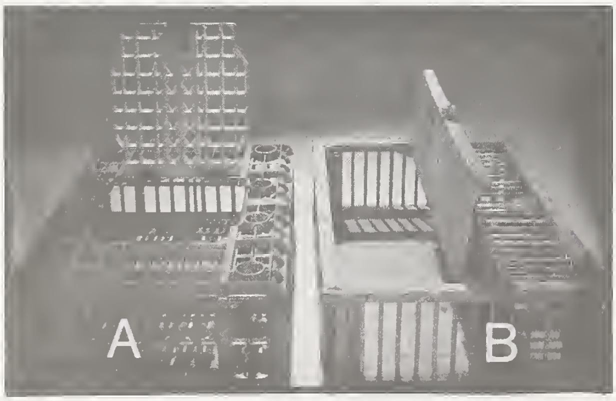

FIGURE 2.—Standard poultry coop (A) and new type of coop (B).

FIGURE 3.—Modified lift truck with hold-down clamp (A).

FIGURE 4.—Transport truck bed modification (A).

herded to a belt conveyor and carried to an open transport truck also equipped with belt conveyors for loading and unloading the birds (Manbeck 1974).

The development of an automated poultry-coop-unloading system began in July 1974, with a prototype (fig. 1) that used a specially designed coop with a side door. Stacks of these coops were placed on a powered-chain conveyor for transportation on demand to a tilting L-shaped frame. When a stack was conveyed onto the L-shaped frame, it was then tilted back 90 degrees. When the stack contacted the frame conveyor, the coops were automatically carried off the frame onto a split-frame conveyor. The weight of the birds against the side door forced it open, dropping the birds onto a moving belt, which transported the broilers to the hanging station. Unfortunately, coops with side doors had much less compressive strength than standard coops, which reduced coop life unacceptably and forced abandonment of the side-door coops.

A new coop with a large door on top was developed for the automated coop unloader. Beginning in February 1975, standard wooden coops were modified in the laborabory and field-tested for catching and loading. Results were promising, and the basic concepts employed in the side-door coop unloader were then applied to a modified unloader that could use coops with large top doors.

This report provides illustrations of the mechanical components of the new receiving-dock handling system and a description of how its units operate, separately and as a complete system.

COMPONENTS

The basic equipment in this automated live-poultry-handling system are a special coop with a large top door, special modifications for a lift truck and transport truck, and a specially designed unloader that conveys, inverts, and empties the coops.

Transport Modifications

Coops.—Standard poultry coops (fig. 2A) with the door in the center of the top are not compatible with this system. The new coop (fig. 2B) was specially designed for automated bird removal and is now commercially available in wood or plastic. The top door is about 11 inches wide and extends almost the full length of the coop. The door has a special friction latch that remains firmly closed when the coops are stacked, transported, or otherwise normally handled, but opens readily when the weight of the birds in the coop presses against the door during the emptying operation.

The coop is versatile; its use is not limited to the automated system. When it is used in conventional coop-handling systems, it makes both catching the birds in the growing house and bird removal at the live-bird hanging station easier. Changeover to automated bird handling can be achieved economically by integrating new coops into a conventional system for a time. New coops can be purchased to replace standard coops as they wear out. An inventory of new coops is thus established before the installation of automated equipment and field-handling and receiving-dock crews have time to learn the changes required in handling techniques.

Lift truck.—A lift truck is used to carry loaded coops from the transport truck to the receiving dock and return empty coops to the transport truck. The mast of the lift truck was modified to handle 40 to 44 coops at a time, and a powered holddown boom was added to the standard lift tines to improve load stability and safety (fig. 3). The holddown boom is hydraulically powered and is controlled by the lift operator. The tines are 8 feet long, and have an inside spacing of about 2 feet, which works well with standard-size poultry coops.

Transport truck.—The bed of the transport truck (fig. 4) was modified by bolting 4-inch by 4-inch, 8-foot-long timbers to the bed of the trailer at 30-inch (center-to-center) intervals. The beams provide access for the tines of the lift truck when stacks of crops are being handled at the processing plant.

Unloading Unit

The major components of the unloading unit (fig. 5) are a feed conveyor; a tilting frame with a short tilting-frame-loading conveyor; an inclined conveyor with an air-operated ram and powered discharge wheels; a bird slide and moving-belt bird conveyor; and an empty-coop conveyor, inverter, and restacker.

Feed conveyor.—Because this system operates efficiently only when the supply of stacked coops is constant, the feed conveyor is designed to

(*Continued on page 8.*)

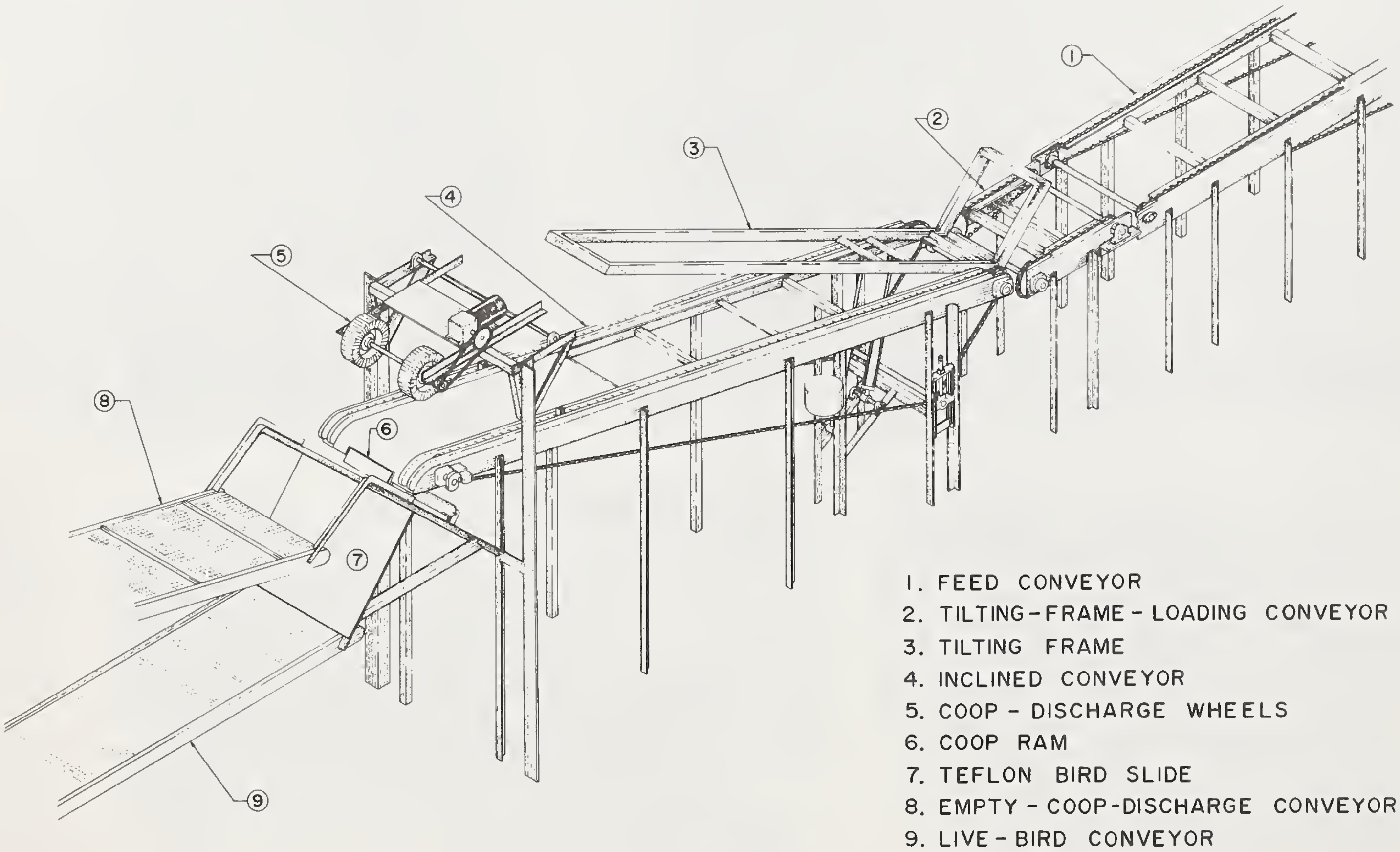

FIGURE 5.—Coop-unloading unit.

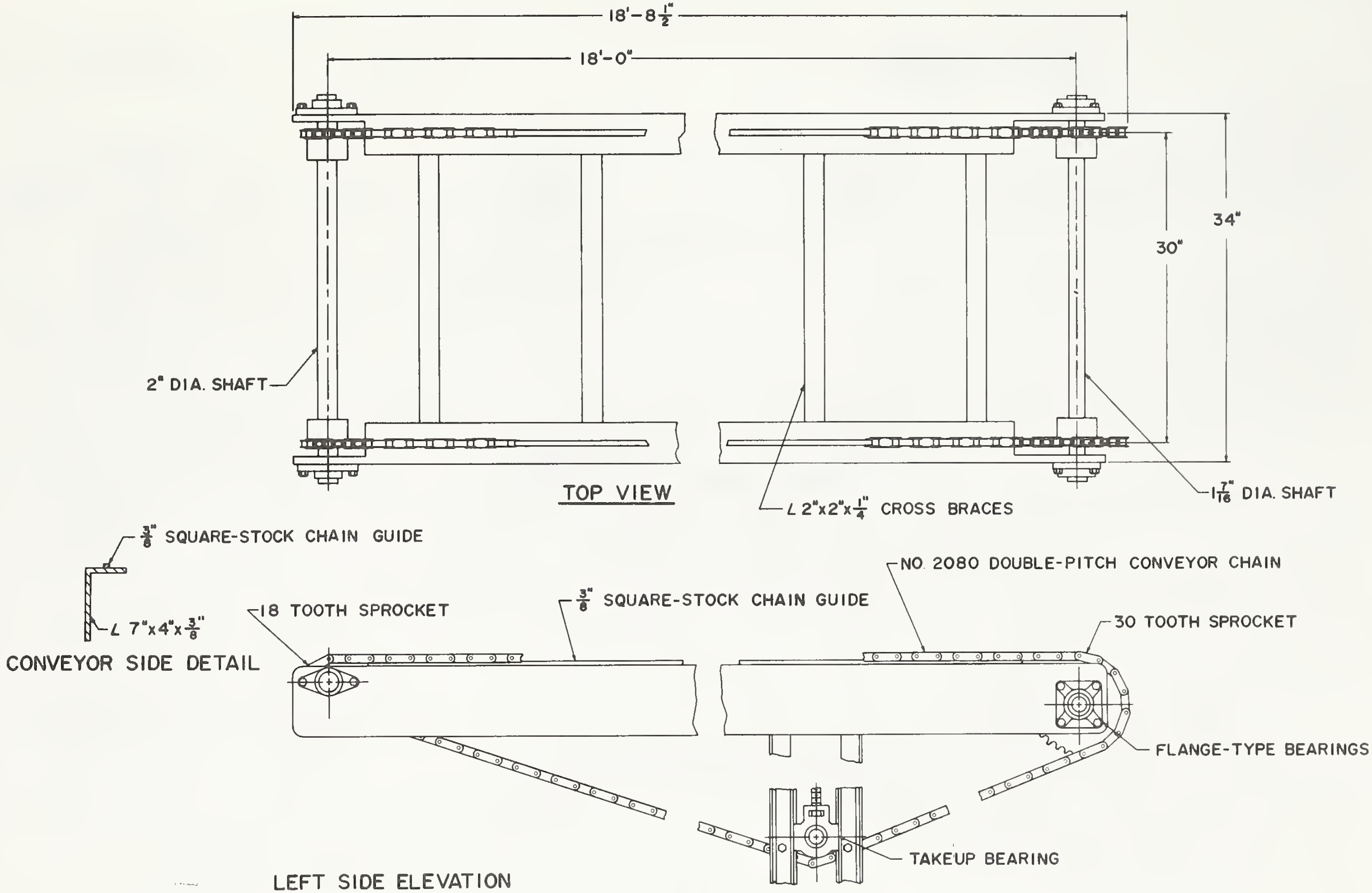

FIGURE 6.—Details of feed conveyor.

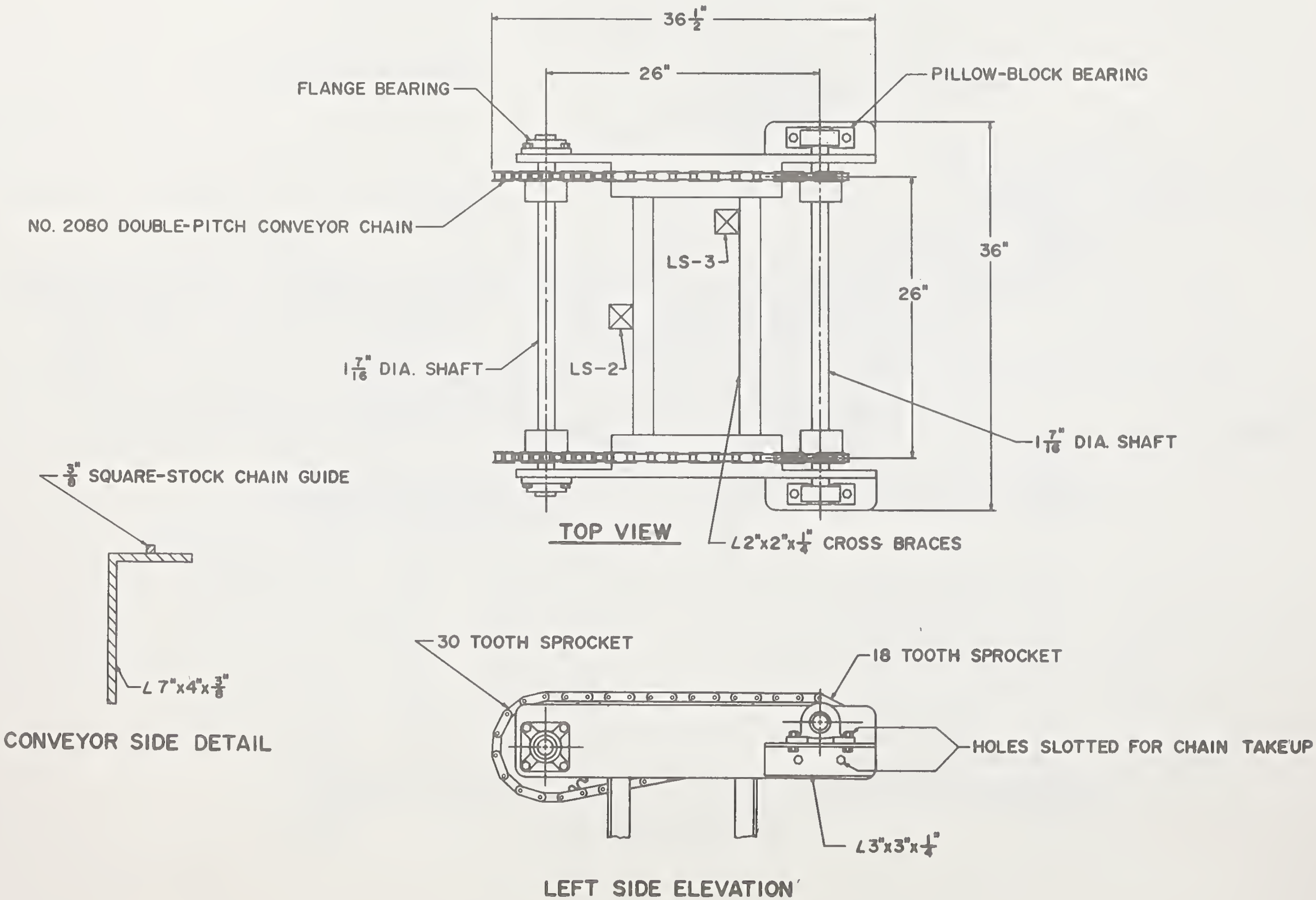

FIGURE 7.—Details of tilting-frame-loading conveyor.

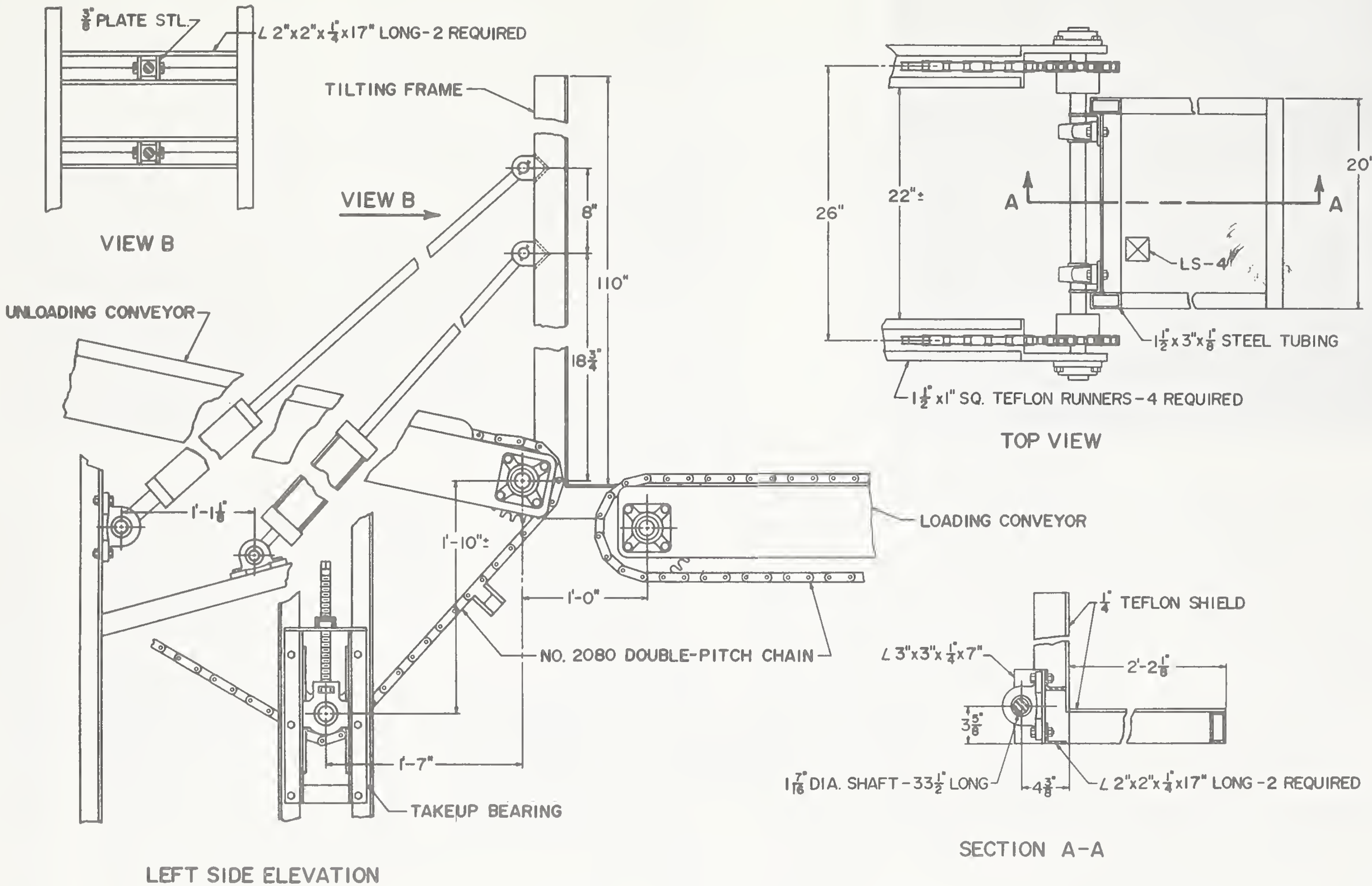

Figure 8.—Details of tilting frame.

function as a temporary holding facility for stacks of full coops and to automatically transfer the coops to the tilting-frame-loading conveyor as needed. The prototype conveyor has a maximum storage capacity of 80 coops (8 stacks of 10 coops each), but this capacity can be increased by lengthening the conveyor.[2] The experimental conveyor is approximately 18 feet long, 4 feet high, and 30 inches wide (construction details are shown in fig. 6).

While one stack of coops is being supplied to the tilting-frame-loading conveyor, another stack is being positioned at the end of the feed conveyor for quick transfer to the tilting-frame-loading conveyor. The stacks must be in position on the feed conveyor to maintain a minimum cycle time. The coops are moved toward the tilting frame by two No. 2080 double-pitch drag chains powered by a 2-horsepower gearmotor. The output shaft from the gear box (rated at 35 revolutions per minute) provides a linear conveyor speed of about 64 feet per minute. At this speed (experimentally determined), more than 10 coops per minute are supplied to the tilting frame, and single stacks can be advanced the length of the conveyor with stability.

Tilting-frame-loading conveyor.—This short conveyor (fig. 7) transfers stacks of coops from the feed conveyor onto the tilting-frame and positions them. The conveyor is designed to allow the tilting-frame platform to ascend and descend between the powered drag chains. Power is supplied to the conveyor by a 2-horsepower gearmotor (rated at 35 revolutions per minute on the output shaft) and linear speed on the conveyor is again about 64 feet per minute.

Tilting frame.—The tilting frame receives a stack of coops from the tilting-frame-loading conveyor, then rotates the coops approximately 78 degrees and loads them onto the inclined conveyor. The rotation causes the birds to shift from the bottom to the side of the coop, which is necessary for the coop to empty automatically.

The mechanical design of the tilting frame is shown in fig. 8. The frame is L-shaped, and made of 1½- by 3- by ⅛-inch steel tubing for lightness and strength. The unit is supported by the inclined-conveyor idler-sprocket shafts, and is connected to each shaft through two pillow-block bearings. The frame is powered by an air cylinder operated at 80 pounds gage pressure. The rotating speed of the unit is controlled by an independently acting hydraulic cylinder. The operation of the hydraulic cylinder is unique; it needs no direct input power. When the frame is raised from the inclined conveyor by the air cylinder, hydraulic fluid is siphoned into the cylinder from a reservoir. As the tilting frame is lowered to the inclined conveyor, the hydraulic fluid is forced out of the cylinder through a flow control valve. Regulating the rate of flow of the hydraulic fluid exerts a positive speed control and a shock-absorbing action that damps movement at each stop position of the frame.

FIGURE 9.—Inclined conveyor moving coops to the emptying section.

Inclined conveyor.—The inclined conveyor (fig. 9) receives the coops from the tilting frame and transports them to the unloading point. Its mechanical design (fig. 10) is critical for efficient coop flow. The conveyor is inclined approximately 12 degrees from the horizontal, the optimum angle (determined experimentally) for unloading the birds from the coops automatically. The unit is 14 feet long between shaft centers, which allows four 10-inch-high coops to remain on the conveyor while the tilting frame returns to the vertical position. These coops are emptied as soon as the

(*Continued on page 14.*)

[2] 80 coops with 12 birds each provides 960 birds, or about 8 minutes production run on a 7,200-birds-per-hour line.

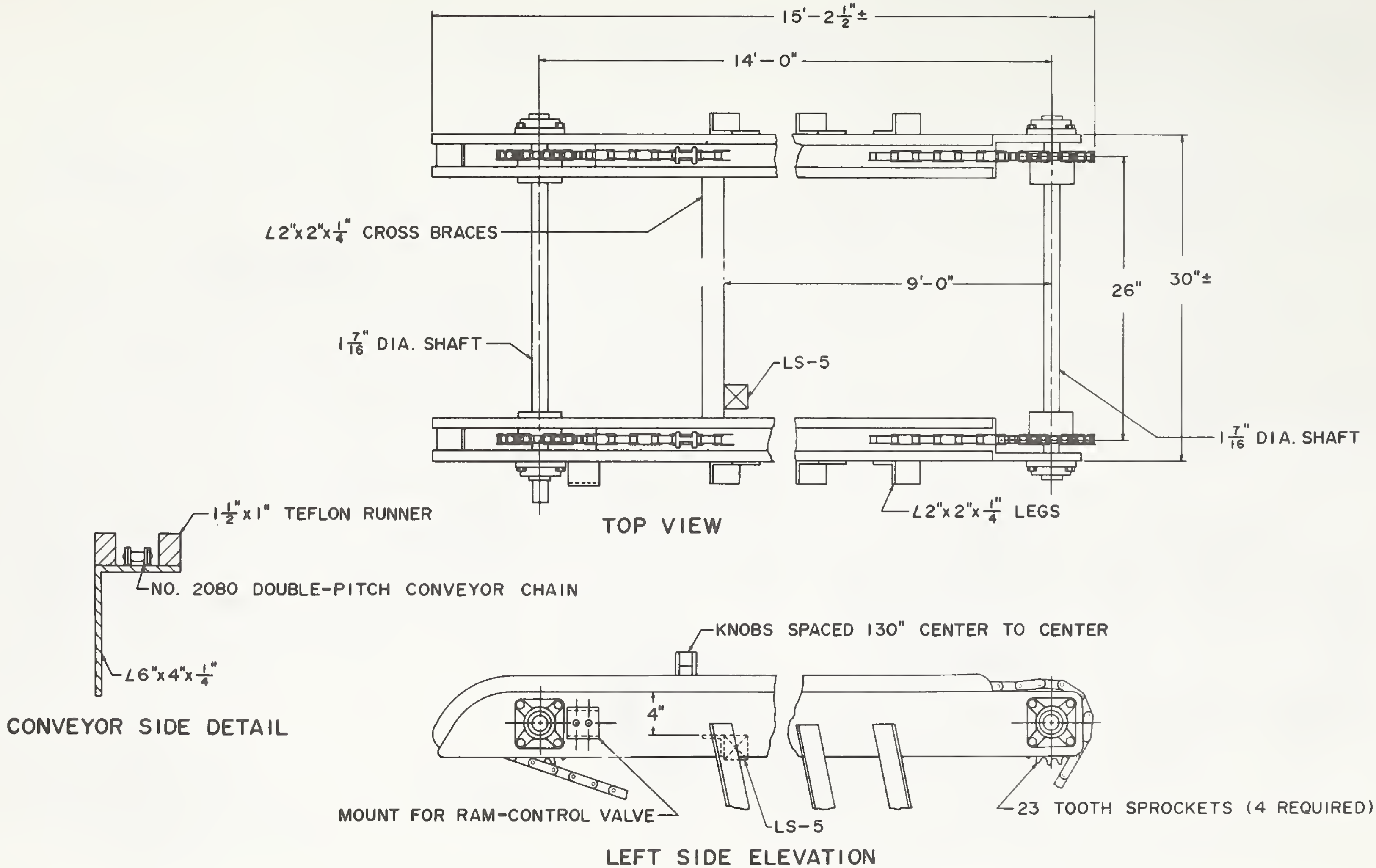

FIGURE 10.—Details of inclined conveyor.

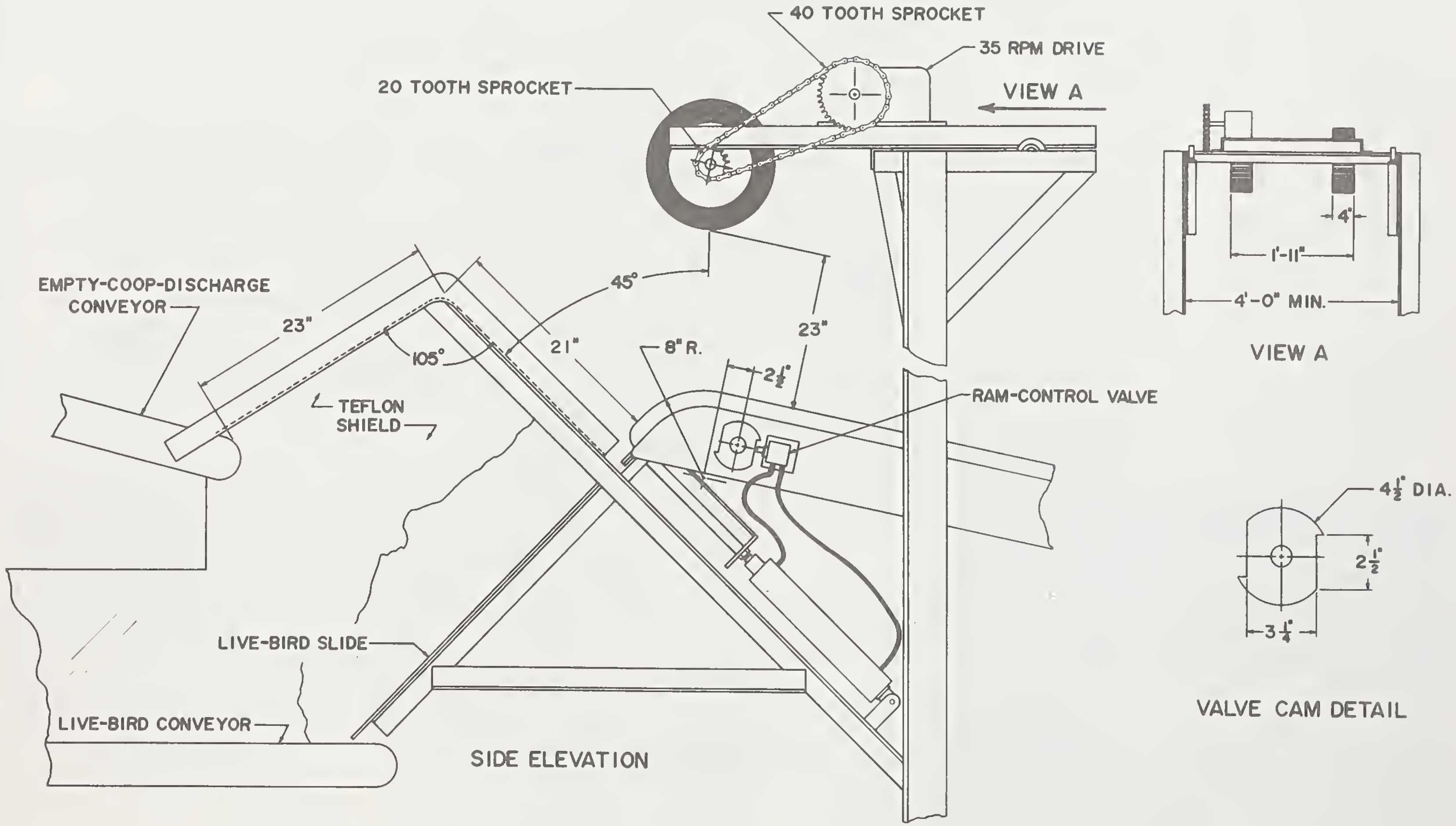

Figure 11.—Details of coop-discharge wheels.

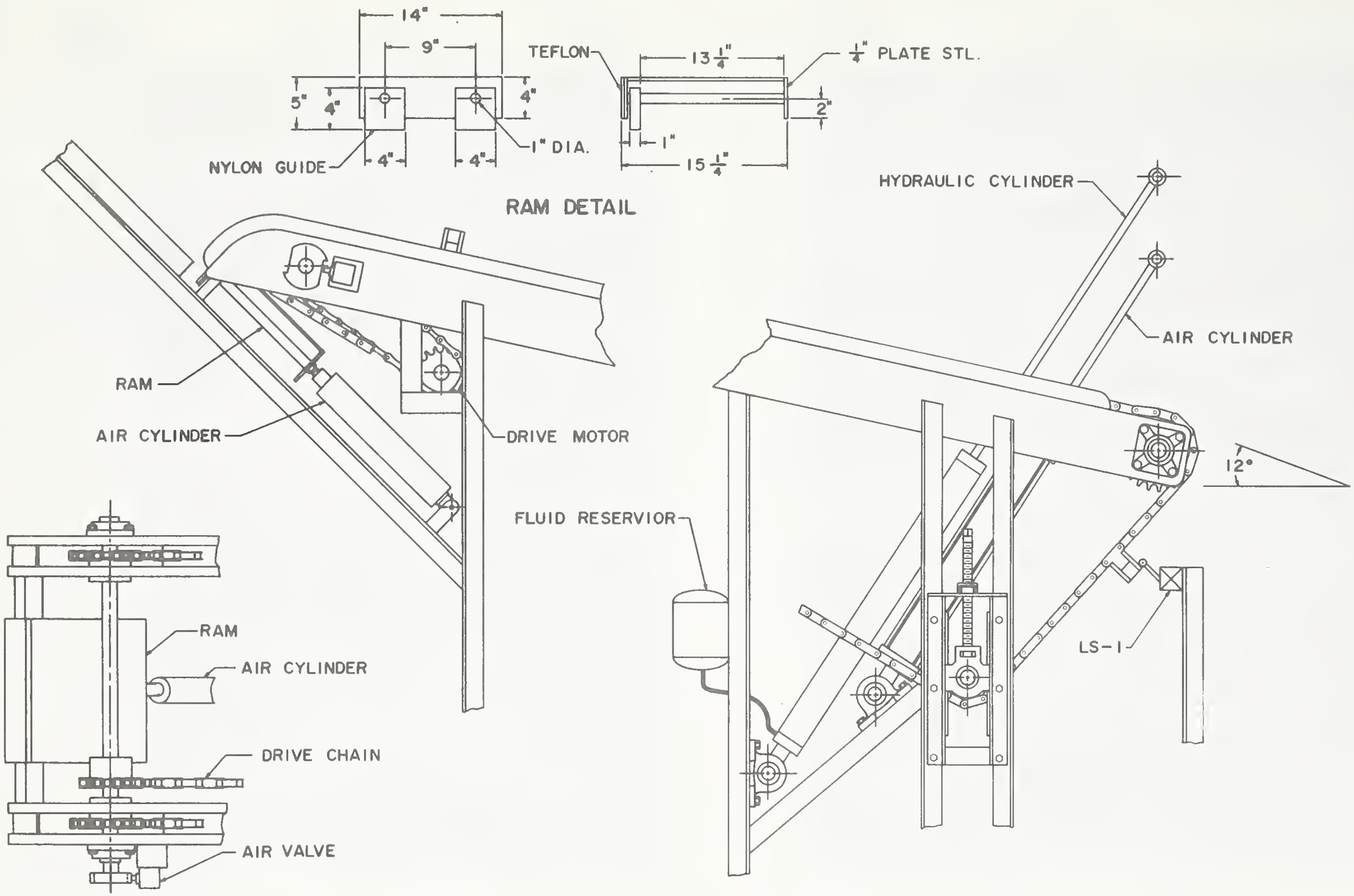

FIGURE 12.—Details of coop ram.

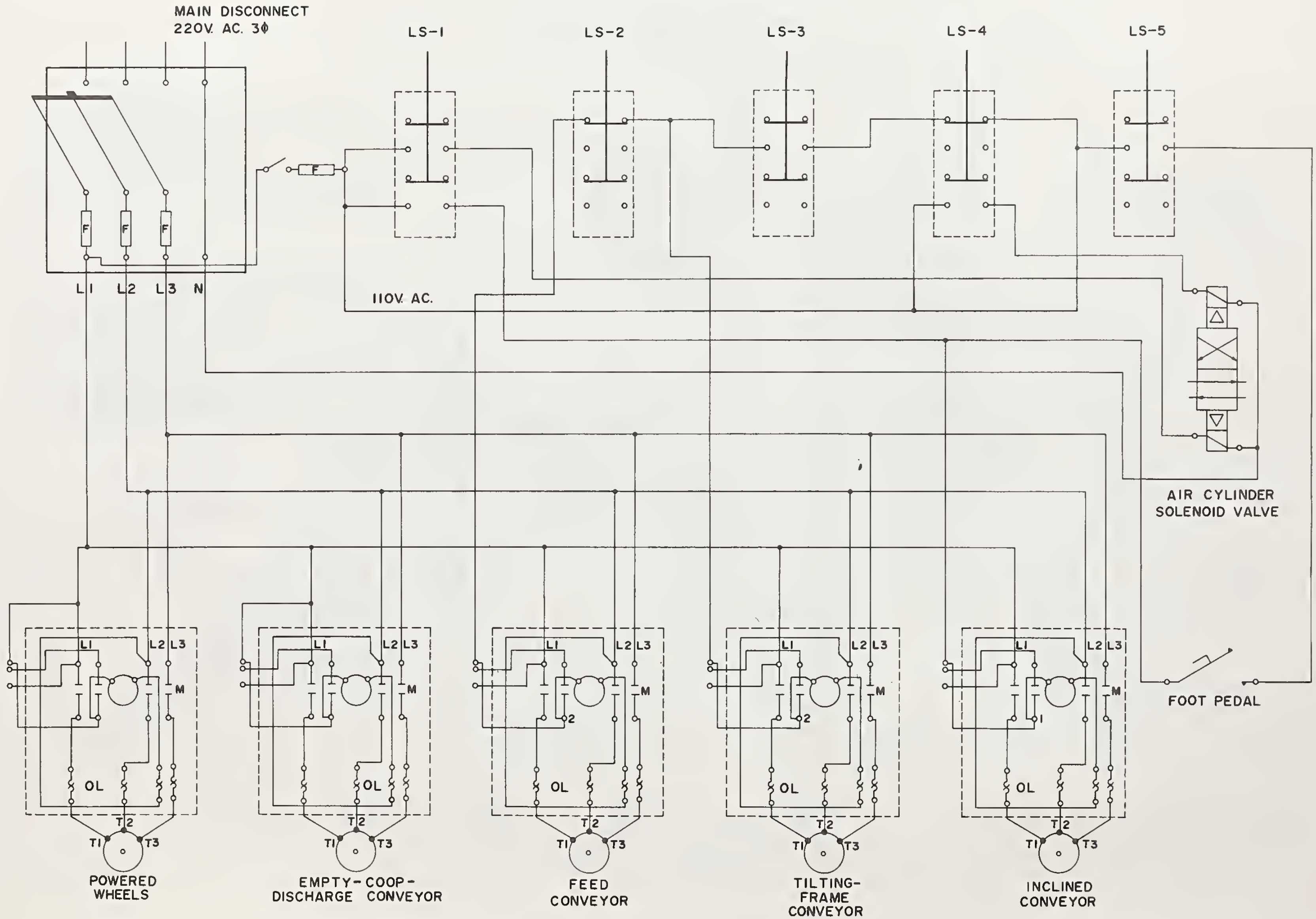

Figure 13.—Wiring diagram of coop-unloading unit.

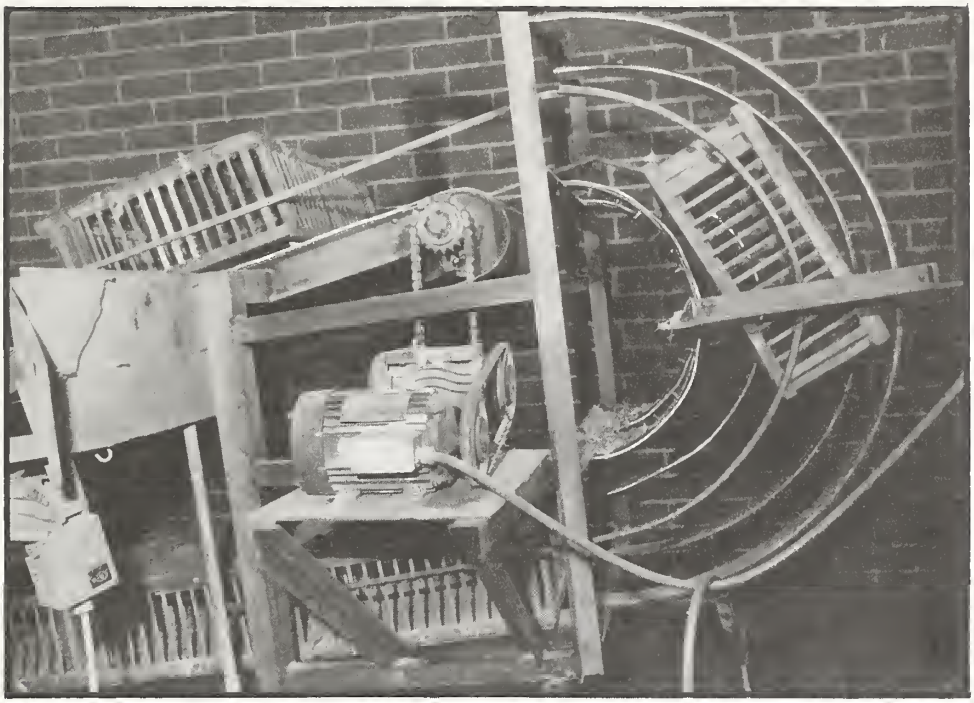

Figure 14.—Empty-coop inverter.

Figure 15.—Restacking station: (A) empty-coop conveyor, (B) empty-coop return, and (C) empty-coop stacking frame.

tilting frame contacts limit switch No. 5 on the inclined conveyor.

The coops are transported to the unloading point by two No. 2080 double-pitch drag chains. The number of sprocket teeth must be an even multiple of 10 to advance the 10-inch-high coop the correct distance for emptying. The chains have three sets of knobs, spaced 130 inches apart, which prevent coops from slipping and force the coops into proper alinement before emptying. The chain and knobs travel between two 1½- by 1-inch Teflon guide runners that provide a low-friction surface on which the coops may slide, and help aline coops properly at the unloading point. The chains are powered by a 2-horsepower gearmotor (rated at 35 revolutions per minute on the output shaft) that provides a linear conveyor speed of approximately 46 feet per minute.

As the coops reach the end of the inclined conveyor (the unloading point), they contact a set of wheels (fig. 11) rotating at 35 revolutions per minute, which exert a horizontal acceleration on the coop and initiate the coop's free fall onto the unloading frame. When the coop contacts the unloading frame, the weight and acceleration of the birds opens the coop door, and the birds flow out of the coop onto a Teflon slide which deposits them onto a moving belt that conveys them to the hanging station. A ram (fig. 12) operated by an air cylinder pushes the empty coop 13 inches up the unloading frame, at which point the coop is unbalanced and tilts over onto the rear of the unloading frame and slides down onto the empty-coop-discharge conveyor.

The wiring of the coop-unloading equipment is shown in fig. 13.

Empty-coop inverter and restacker.—The empty coops exiting the bird unloading section are conveyed on their tops on a 2-foot-wide conveyor moving at 60 feet per minute. They are inverted by gravity (fig. 14) and slide down a roller conveyor to the restacking station (fig 15), where a worker rotates the coop 90 degrees and places it onto the stacking frame. The stacking frame (fig. 16) is 11 feet long and holds 11 coops (each 10 inches high).

To control the frame, the worker presses a foot-pedal switch (LS-1, fig. 17) that activates a hydraulic control valve and applies power to a hydraulic main cylinder. The main cylinder is connected to the stacking frame and rotates the frame for loading and unloading stacks of coops.

When the stacking frame is in the loading position, limit switch 2 (LS-2, fig. 16) energizes the clamp-arm solenoid valve, which extends (opens) the coop-stabilizer arms. The control circuit to the clamp-arm solenoid valve is wired on the normally open contacts of LS-2. When the stacking frame is raised off of LS-2, the electrical path to the clamp-arm solenoid valve is interrupted and the coop-stabilizer arms close against the coops. The coop-stabilizer arms apply pressure to each side of the stack to control the coops while the frame rotates them to the vertical position.

To unload the coops, the worker presses LS-1, the stacking frame rotates to the vertical position and the bottom coop contacts limit switch 4 (LS-4, fig. 16), a double-pole, single-throw switch that activates the time-delay relay (fig. 17) and the accumulating conveyor. The time-delay relay energizes the solenoid valve that controls the clamp-arm hydraulic cylinder. After a delay of about a second (to help stabilize the stack of empty coops), the coop-stabilizer arms release the coops. After the coop-stabilizer arms have released the coops, the worker activates a foot-pedal switch (LS-7, fig. 17), energizing the empty-coop-unloading conveyor, which moves the coops off the stacking frame onto the accumulating conveyor.

The empty-coop unloading conveyor (fig. 16) uses No. 60 double-pitch chain and is 7 feet long between shaft centers. The conveyor is powered by a 1-horsepower gearhead motor (rated at 35 revolutions per minute at the output shaft that provides a linear speed of 60 feet per minute on the chains. Knobs (fig. 16) attached to the chains, at 84-inch intervals (center to center) push the coops off the stacking frame and transport them to the accumulating conveyor. As the coops travel to the accumulating conveyor, contact is made with limit switch (LS-5, fig. 16), which energizes the main-cylinder solenoid to return the stacking frame to the horizontal position for coop reloading.

The accumulating conveyor (fig. 16) stores 8 stacks of 11 coops each. The conveyor is powered by a 1-horsepower gearhead motor (with a 35-revolution-per-minute output shaft) that moves the chains at a linear speed of 60 feet per minute. Knobs attached to the chains at 96-inch intervals (center to center) push the coops onto an 8-foot-long power-free storage section. The storage section is a split-frame platform with four 1-inch-wide strips of Teflon to provide a low-friction

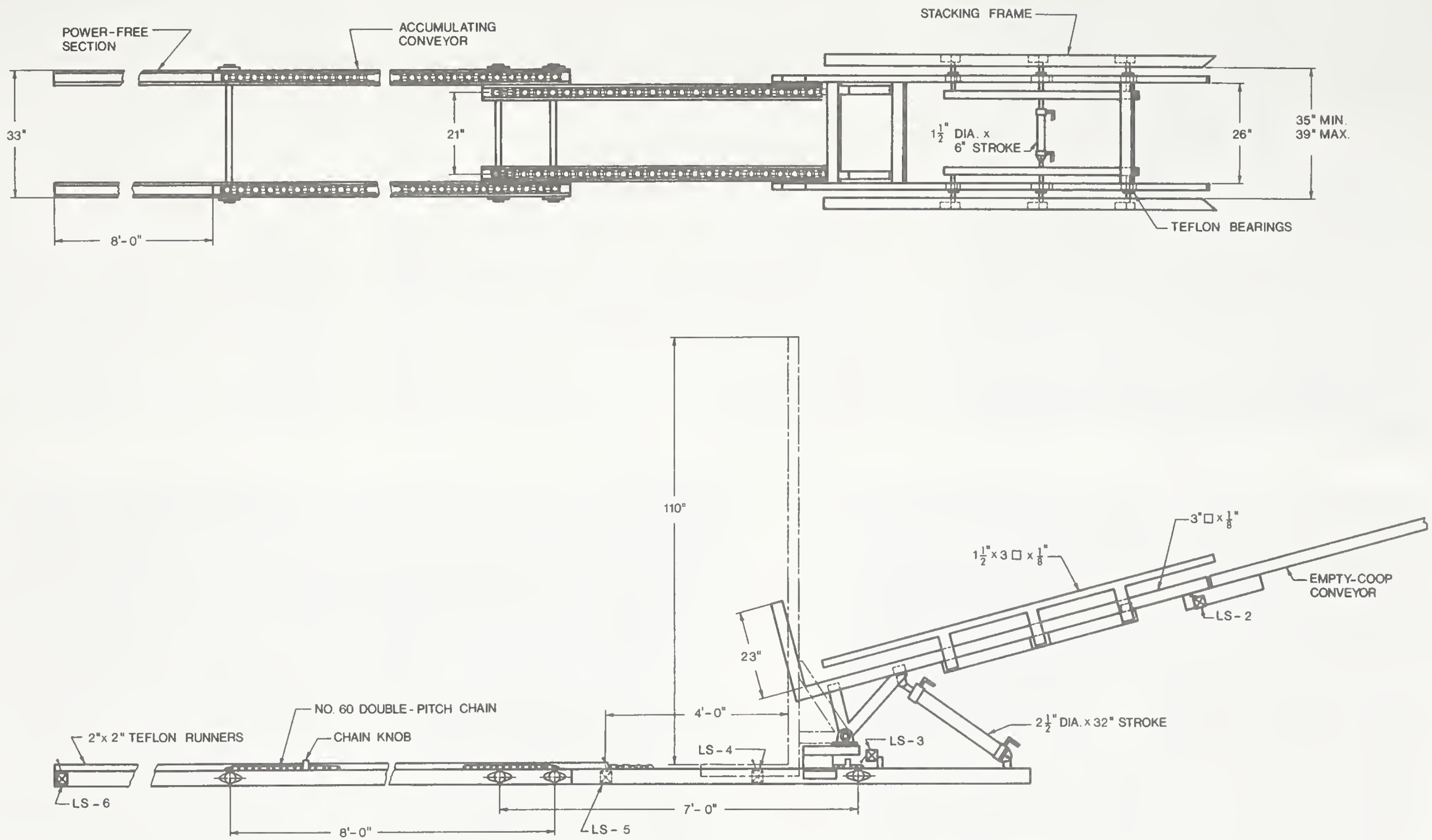

FIGURE 16.—Details of empty-coop restacker.

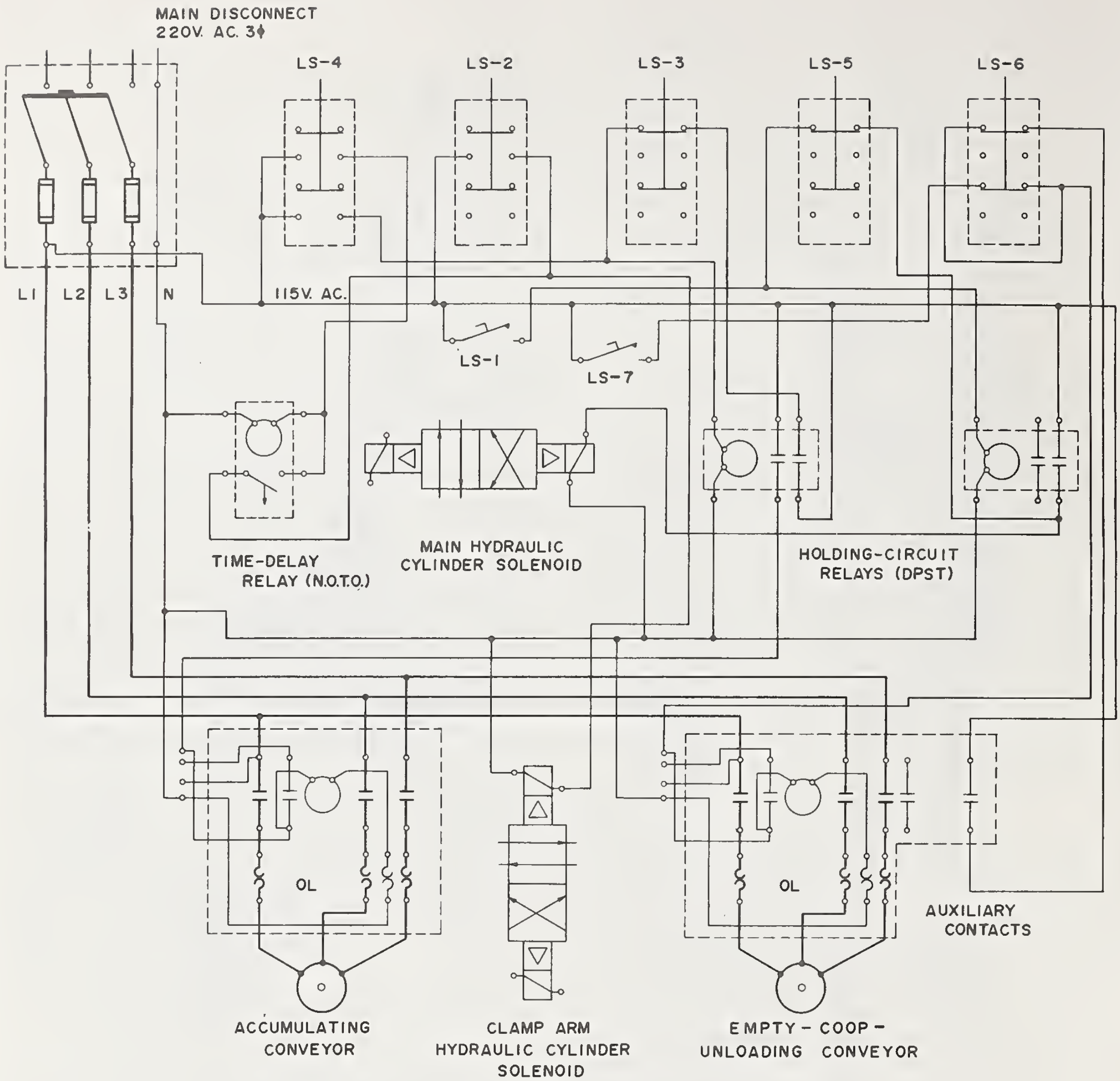

Figure 17.—Wiring diagram of restacking equipment.

surface that allows stacks of coops to be meshed together tightly so the lift truck can handle the stacks more efficiently when placing them back onto the transport truck. At the end of the power-free section, a switch (LS-6, fig. 16) controls the power to the conveyors. When a stack of coops contacts this switch the conveyors stop, preventing stacks from being pushed off the end of the power-free storage section.

The power-free section is constructed to allow the lift truck tines to enter the conveyor beneath the stacks as shown in figure 18. The lift truck removes four stacks of empty coops from the the conveyor and carries them to the transport truck.

OPERATION

When the system is ready to receive stacks of coops and begin operation, the feed conveyor and the tilting-frame-loading conveyor are empty and the tilting frame is in the vertical position, ready to receive coops. When the system is electrically energized, the feed conveyor, tilting-frame-

FIGURE 18.—Lift truck removing stacks of empty coops.

FIGURE 19.—Lift truck loading coops on the feed conveyor.

loading conveyor, coop-discharge wheels, live-bird conveyor, and the empty-coop-discharge conveyor begin operation. The lift truck operator loads the feed conveyor with stacks of full coops (fig. 19). As the stacks are advanced by the feed conveyor (fig. 20), the first stack conveyed onto the tilting-frame-loading conveyor contacts a limit switch (LS-2, fig. 7), stopping the feed conveyor. Another limit switch (LS-3, fig. 7) keeps the electrical circuit for the tilting-frame-loading conveyor energized. This sequence insures that stacks of coops on the tilting-frame-loading conveyor and the feed conveyor are properly spaced. The stack continues on the tilting-frame-loading conveyor, and contacts another limit switch (LS-4, fig. 7) which stops the tilting-frame-loading conveyor and energizes the solenoid valve which controls the air cylinder on the tilting frame.

The tilting frame rotates the coops (fig. 21) until contact is made with the inclined conveyor. The air cylinder begins the rotation of the tilting frame, and the hydraulic cylinder damps the tilting frame's movement. When the mechanical forces acting on the air cylinder change from tension to compression, the hydraulic cylinder takes the compressive load off the air cylinder, providing smooth operation, and preventing the loaded frame from falling free onto the inclined conveyor.

Once the tilting frame contacts limit switch 5 (LS-5, fig. 10), the inclined conveyor can be

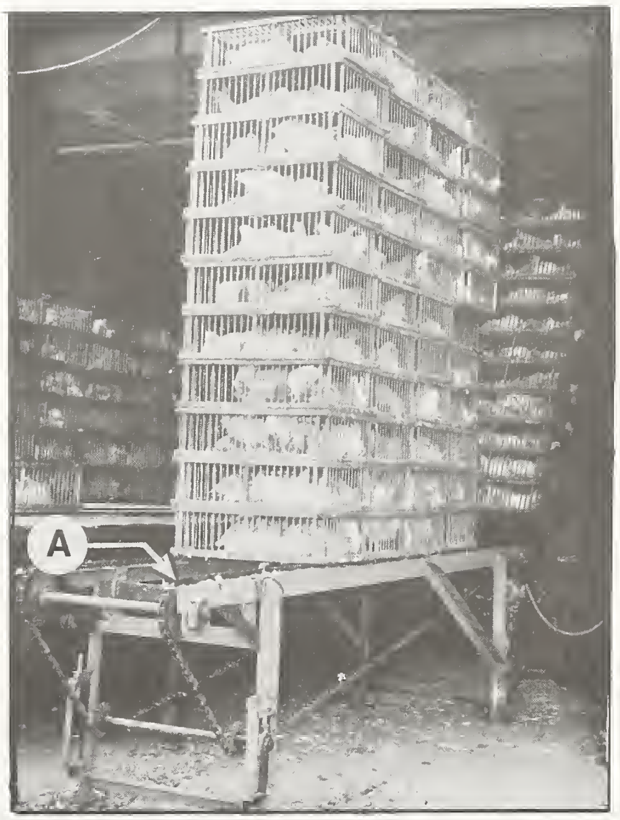

FIGURE 20.—Feed conveyor (A) loaded with coops.

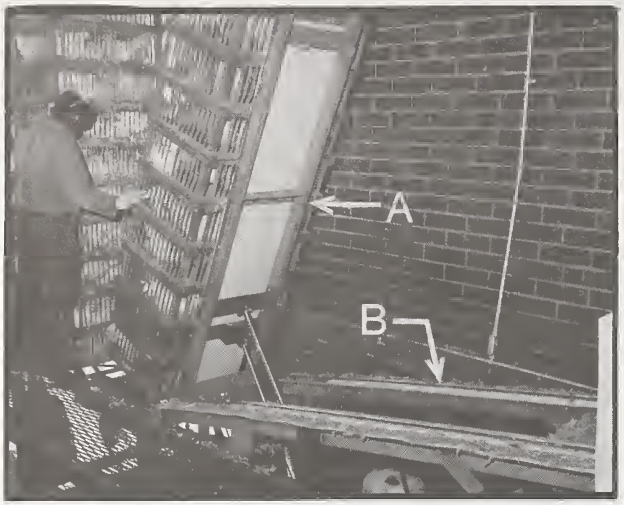

Figure 21.—Tilting frame (A) loaded with coops rotating to inclined conveyor (B).

Figure 22.—Poultry exiting coop at the unloading point.

energized by a worker at the hanging station by pressing a foot-pedal switch. LS-5 is wired through normally open contacts to prevent the inclined conveyor from operating when the tilting frame is not resting on the switch. In coops loaded on the inclined conveyor, the broilers are resting against the side and the door in the top of the coop. As the coop contacts the rotating coop-discharge wheels the top of the coop is accelerated and the coop falls free. During the fall the top door starts to open and the birds begin sliding out (fig. 22). Once the coop comes to rest on the unloading frame, the broilers exit the coop onto the slide. The loose birds slide down a Teflon surface onto a moving belt which transports them to the hanging station.

When the coop contacts the unloading frame, the ram pushes it up the incline to a point where the coop automatically tilts over and slides down the back side of the unloading frame onto the empty-coop-discharge conveyor, The ram removes the coop and helps shake out any birds that did not exit when the coop was first inverted. The ram (fig. 12) is powered by an air cylinder which is activated by a cam-operated control valve. The design of the cam depends on the linear speed of the inclined conveyor; ram operation must be synchronized with the conveyor speed to prevent a coop from falling on the ram when it is in an extended position.

The inclined conveyor continues delivering coops to the unloading section as long as the workers hanging birds need them. After starting up, the system is controlled by the foot-pedal switch operated by the lead worker at the hanging station. When the bottom coop clears the tilting frame, a knob on the conveyor chain contacts limit switch 1 (LS-1, fig 12), a double-pole, single-throw switch that activates the air-cylinder solenoid, which applies power to return the tilting frame to the upright position to receive another stack of coops. LS-1 also provides a momentary control circuit to the inclined conveyor; it energizes the inclined conveyor long enough to move the knob off LS-1 to prevent the tilting frame from moving up and down continuously.

When the broilers exit the coops, the ram pushes the coops onto the empty-coop-discharge conveyor. The empty coops are transported to a restacking station where a worker places them on a stacking frame. When the desired number of coops is in place on the stacking frame, it is rotated to the vertical position for unloading. The stack of empty coops is conveyed from the stacking frame onto an accumulating conveyor, which provides a temporary storage for the empty coops. The modified fork lift truck removes four stacks of coops from the accumulating conveyor, and carries them to the transport truck.

SPECIFICATIONS

Figures 5-8, 10-13, 16, and 17 illustrate the main components of the coop unloader and the restacker. The dimensions are those of the final prototypes installed at the plant. All drives, bearings, chains, and shafts are stock items. Hot-rolled angle, channel, and plate steel were used throughout the design. Teflon bar stock and sheet material were used to provide tough, low-friction surfaces. The belt conveyors are made of polyvinyl chloride, a material that has proven to be highly durable. The electric motors, micro-switches, and solenoids for air and hydraulic cylinder controls are also standard items. The air-cylinder circuits require a regulator, filter, diverter valve, and air dryer.

The hydraulic cylinder is connected to a fluid reservoir through a flow-regulator valve. The reservoir was constructed from a 5-gallon tank, with the hydraulic fittings welded in place. Since the reservoir is operated under low pressure, it can be made from any thin-walled container that will not be corroded by the hydraulic fluid.

EVALUATION

This system was developed under operating conditions in a commercial poultry-processing plant. Design problems were discerned readily, solutions were tested, and modifications were made under actual working conditions.

Automated receiving-dock equipment (new coops, coop-holddown boom, feed conveyor, tilting frame, inclined conveyor, empty-coop inverter, belt conveyors, restacker, and accumulating conveyor) requires a significant investment. An equally important consideration is coordinating the installation of new equipment and training of personnel to operate and maintain the new system. There must be excellent communication between management and the personnel involved in live handling; all live-handling and receiving-dock personnel must make a special effort to work together.

In the field, the bird-catching crews must learn how to handle the new coop with its larger door and different hinge and latch arrangement. All coops must be loaded with the doors opening in the same direction. A coop stacked in the wrong direction will not unload automatically, and a worker must take the coop off the line and manually remove the birds, slowing receiving-dock operations significantly.

The coop unloader we developed is compatible with the squeeze lift truck operation some processors already use. Any field-handling methods can be used as long as the new top-door coop is also used. The unloading system handles 11 coops per minute (120 to 150 birds per minute), and only one worker each is required to operate the coop-unloading machine and the restacker. There has been no excessive downgrading of carcasses in plants using this system.

A major advantage of this system is that it reduces labor required at the plant hanging station. When broilers are transported into the hanging cage on a belt conveyor at 7,200 birds per hour, only five workers are required to perform the hanging operation. Conventional systems (in which full coops are conveyed into the hanging station) require six or seven workers to hang 7,200 birds per hour. By converting to the mechanized unloading system, poultry processors can save approximately 30 percent in labor in the receiving area, and reduce the amount of heavy physical work involved in hanging the birds.

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